Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. I. NEW YORK, OCTOBER, 1896. No. 8

A COMPRESSED AIR HOIST FOR MERCANTILE PURPOSES.

Compressed Air

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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Electricity and compressed air are in many things friends not competitors. One should be the hand-maiden of the other to give mutual aid and encouragement. In some things electricity is supreme, and though compressed air were "as free as air" it could not compete. Friendly rivalry of this kind is the very essence of development and prosperity.

Manufacturers of air compressing devices and all friends of compressed air will agree that the stimulus given them by recent developments in electricity is at the bottom of present prosperity in air compressing and air using devices. Competition has not only been the life of trade in this line, but engineers and inventors have watched and profited by the new uses of electricity, creating as it has new fields, in some of which air power serves a useful purpose. An instance of this co-operation is seen in most of the large railway yards in America.

The Electro-Pneumatic switch and signal system is a combination of compressed air and electricity, each performing its part, and each recognized as the best power for the purpose. This system is considered the most comprehensive now in use. It is in constant operation at the Pennsylvania R. R. terminals in Jersey City, Philadelphia & Pittsburg; the Philadelphia & Reading terminal, Philadelphia; the Union Station at St. Louis; the Chicago and North Western R. R., terminal Chicago; at the Boston & Maine terminal, Boston, and the Communipaw yards of the Central R. R. of N. J. The compressed air may be conveyed along the road bed 20 miles in each direction from the compressor station. Electricity runs parallel with it and serves to open or close valves which admit compressed air to pistons which are connected with the switches and signals.

Electricity handles the trigger while compressed air is the power which does the work.

Here is where air power comes in to the best advantage. It may be transmitted a long distance with little or no loss provided the pipes are tight and the velocity of flow is not excessive. It does not lose power through changes in temperature.

When released or led from the main into a cylinder it acts instantly with a force that is limited only by the area of the piston and the air pressure. After doing its work it is readily exhausted. All this is accomplished by very simple apparatus that is easily understood and readily repaired in any machine shop.

We mention this as one and perhaps the most important case where electricity and compressed air are combined in useful service.

A pneumatic door lock, for freight car doors, which will not only keep the door closed, but will also give alarm to the trainmen in case the door is opened, is among recent inventions.

An Air Hoist for Mercantile Purposes.

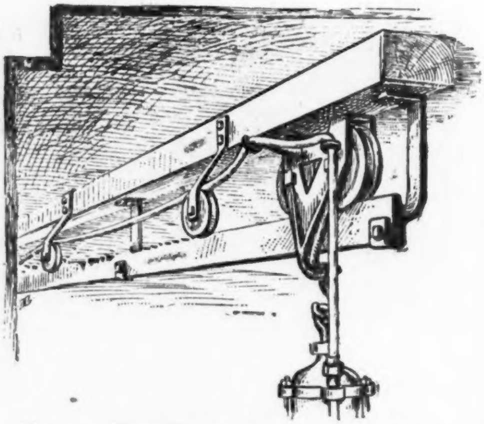


FIG. 1.—THE UPPER PART OF AIR HOIST SHOWING TROLLEY AND HOSE.

Pedestrians who pass the store of the Nason Mfg. Co., 71 Beekman St., New York, are often puzzled by the ingenious method employed in unloading boxes, barrels, radiators, bundles of pipe, crates of earthenware, boilers, ranges, furnaces and innumerable other heavy pieces, from the dray that stands in the street in front of the door. A crane is swung over the sidewalk, as illustrated on the cover of this number of COMPRESSED AIR, and it supports a hanging cylinder which has been conducted from the interior of the store upon the trolley rail of the crane. To the cylinder is attached a line of flexible rubber hose, which being supported on rollers having anti-friction bearers, leads to the rear of the store, where it winds or unwinds upon a metallic drum, as the trolley is pushed backward or forward upon its rail. Compressed air at from 65 to 75 lbs. pressure is supplied to the cylinder through the hose—it being taken in through a stuffing box at the centre of the drum. The air is stored in a suitable reservoir, into which it is pumped by a small compressor—the latter starting and stopping automatically by means of variation in the air pressure.

When the cylinder reaches the proper point it hangs pendant over the load of merchandise; the driver of the dray opens a valve and thus admits the compressed air beneath a piston. A piston rod projects through a stuffing box on the under side of the cylinder, and being provided with a hook, clamps of varying patterns which are hung to it are attached to the article to be unloaded. The valve is closed and another one opened, when the load rises and is then readily pushed into the store and deposited in its proper place along the line under the track.

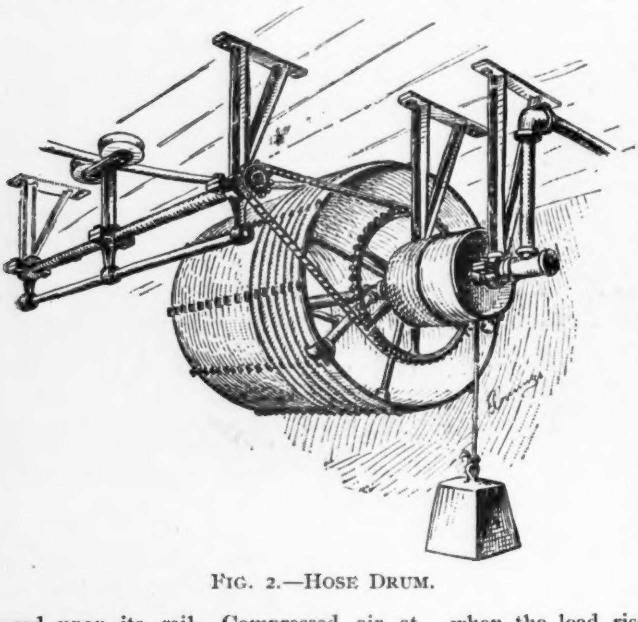
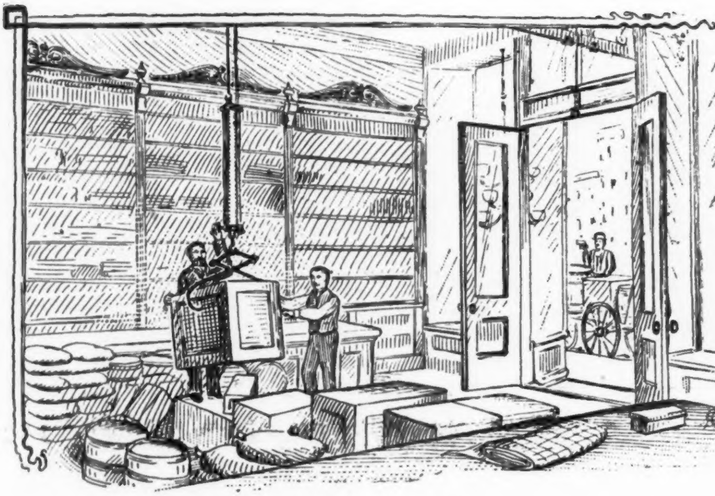


FIG. 2.—HOSE DRUM.



UNLOADING MERCHANDISE IN STORE.

The cylinder is the oft-described "air hoist," and this particular one, combined with the rest of the apparatus, is known as the "Nason Pneumatic Lift." It was designed and patented by Mr. Carleton W. Nason several years since, and has been in operation at the stores of the Nason Manufacturing Company for about three years, during which time not a cent has been expended for repairs of any sort.

Fig. 1 shows a piece of the track with the trolley on it, and also the means of supporting the hose between the trolley and the revolving drum. This feature is both important and necessary, as it permits of an extension of the line up to, say, 150 feet in length without undue friction.

Fig. 2 shows the reel with the device for winding the hose upon its pitch line, which is accomplished, it will be noticed, by means of a pair of rolls fastened to a carriage which slides upon a lead screw—the latter being driven by a pair of sprocket wheels and chain belting—their dimensions being such that the central point between the rolls is always opposite the point on the drum upon which the hose is to be rolled. A weight suspended from a smaller drum, which is attached to a shaft common to both drums, takes up the slack of the hose between the rolls, and keeps it always under moderate tension.

When our artist appeared upon the scene, a large 4 x 24 radiator was being taken off the dray and into the store. Its weight was about 600 pounds, which is much within the capacity of the lift. The cylinder in use with this hoist being five inches in diameter, it gives a lifting capacity with the air pressure used of about 1250 pounds. Other stores in the city are about to be equipped with the Nason Lift,

and its use may extend to a long list of applications in commercial lines and wherever h:avy articles are to be transferred. This hoist is particularly valuable in New York, Boston, and other places where narrow streets abound. The load is discharged rapidly and relieves the blockade that so frequently occurs on these streets. Ships may be loaded and unloaded in the same manner. The time that may be saved in discharging cargoes would also play an important part in increasing the facilities and decreasing t e cost of ocean transportation.

A WAR-SHIP RUN BY AIR.

Machinery which May Revolutionize Naval Methods.

Of all the vessels now lying in the Brooklyn Navy-yard, the new United States monitor Terror is the most interesting. She is not, by any means, the original "cheese-box on a raft," for her two turrets, smoke-stack, armored ventilator, etc., form a varied superstructure, very different from the single, low, round turret of Ericsson's Monitor. Quite a number of years back Congress appropriated money to build five of these vessels — the Puritan, Amphitrite, Miantonomah, Monadnock, and Terror— but the appropriation was only sufficient to complete the hulls, and they lay unfinished until about six years ago. Then further appropriations were secured, and the vessels have been gradually completed. The Puritan is not yet entirely fitted up, and the Terror has but lately gone into commission, having recently been on a trial cruise of two weeks.

The Terror differs fr m her sisters in that the Navy Department contracted with the Pneumatic Gun and Power Company to install pneumatic machinery upon the Terror only, for turning the turrets, working the guns, steering the ship, etc. The other monitors have hydraulic machinery for their turrets and guns, and are steered by steam. The Terror, indeed, is the only vessel, in all the navies of the world, in which pneumatic power is thus applied, aud is t erefore a practical experiment whose success may lead to far wider use of the pneumatic principle.

The use of compressed air has several advantages over ste m or hydraulic power. All pipes are liable to leak ; and a leak in a steam or water pipe, in a turret crowded with guns and machinery in action, is inconvenient, if not dangerous, and requires both time and patience to repair it, when neither is likely to be available. In an air tube, on the contrary, a leak causes no inconvenience — since the waft of air from it would be rather agreeable to the men at the guns than otherwise — and, with a surplus of supply air, requires no immediate repair. Again, steam and water systems require exhaust pipes, whereas in the pneumatic system the exhaust is turned either into the turret or the open air, as desired.

The Terror has two engines for compressing the air, one situated in the hold near the forward turret, and the other on the berth deck near the after turret. Either of these, singly, can supply sufficient air, at a pressure of 125 feet per square inch, to operate both turrets, including the guns—a total weight of nearly 500 tons. The compressor takes its supply of air from the chamber in which the engine stands, and compresses it in two cylinders, sending it also through two condensing cylinders, where it is cooled by circulating sea-water. It is then carried by pipes and two engines, of two cylinders each, situated on each turret floor, precisely like steam-engines, about fourteen-inch stroke and eight inches diameter of cylinder. These develop about forty horse-power each, and are controlled by a lever in the sighting hood of the turret, over and between the guns, where are also situated the elevating levers. The movement of both turret and guns is thus controlled by the officer who sights and fires the latter.

Beneath the turret-chamber proper, where the guns are mounted, is the loading-chamber, with the magazine on its starboard, and the shell-room on its port side. The shell, which weighs 500 pounds, and a cartridge, in two parts, containing 240 pounds of powder, are run out into the loading room by a single overhead trolley, and dropped into a lift, which is swung around until the shell is opposite a loading car, into the lower compartment of which it is slid, partly by its own weight, while the cartridge is placed in the upper division. The car is then hoisted to the breech of the gun, by means of another pneumatic cylinder, placed upright between the guns. The car stops, automatically, when the shell is opposite the breech-chamber, aud the rammer (telescopic in form, and also operated by compressed air) pushes the shell to its seat, and the cartridges follow. Usually, in these heavy guns, a loading-tray is placed in the breech to facilitate the entrance of shell and cartridges; but in the Terror the loading-car, as it ascends, throws the tray automatically into position, and when the loading is finished the tray is thrown out again, and the breech-block thrust into place by the pneumatic rammer, thus leaving the gun in complete readiness to be fired. So thorough and perfect are all these automatic adjustments, that the guns in either turret can be loaded independently, and in any position of train or elevation. All parts of the gun-carriage and turret move together, except one—that being the fixed central column through which the air-pipes and communication pipes pass into the turret and up to the sighting-hood.

To elevate and depress the guns, there is on either side the turret a cylinder, containing glycerine and water, which is forced by compressed air into the elevating ram under the breech of the gun. This is regulated by double valves, and is controlled, also, by the officer who sights the guns. The guns are fired, either independently or together, by means of an electric push-button. The crew for the two guns of a turret comprises ten men. This is somewhat of a change from the time of the civil war, when twenty-five men were required to work a single heavy gun.

The recoil of the guns is controlled by two pneumatic cylinders, forty inches in length and fourteen in diameter. Before firing, these cylinders have a pressure, on the recoil side of the piston, of about 500 pounds per square inch, which is drawn from a special plunger attached to the compressing engine. The recoil cylinders are secured to the gun carriage, and the pistons to the gun. When the gun is fired, the pressure upon the recoil side of the piston is rapidly increased by compression. A tapered rod, passing through the centre of the piston, permits the air to pass more and more freely to the counter side, thus equalizing the pressure at the end of the recoil. By this simple arrangement, the recoil of the guns is limited to about thirty-four inches. At the end of the recoil, the pressure upon the recoil side of the piston operates upon a greater area, and immediately returns the gun to its place. The recoil and counter-recoil are both without shock, the air cushion preventing any sudden stopping of either.

The ship is also steered by compressed air, the steering-room being abaft the cabin. The shaft which operates the pneumatic valve has three clutches upon it besides the steering-wheel, by means of which the control of the rudder may be transferred to either turret, or to the pilot-house. The Terror is also fitted with an electric motor of five horse-power, and with hand-wheels, so that she can be steered either by electricity or by hand, if necessary. In actual size, she is about one-half as large as the Indiana class of battleships, but in proportion is far more powerful. She has a displacement of 4,000 tons, and is 260 feet long and 56 feet beam. She draws 15 feet of water, and

with 250 tons of ammunition on board, and her bunkers full of coal, her freeboard is only 27 inches or so. In an ordinary sea, therefore, her deck is more or less awash, and this renders her a peculiarly elusive target to the enemy. Her speed is about 10 knots, which is ample for the purposes for which she is intended.

With the new smokeless powder, her four ten-inch guns will give each of their 500 pound projectiles an initial velocity of about 2,400 feet per second which gives an energy of about 20,000 foot-tons—a force which, applied properly, wou'd be sufficient to lift the Terror herself bodily five feet at each shot; and as these guns can be fired at the rate one gun every thirty seconds (the turret revolving once a minute), some idea of her power may thus be gained. The guns carry seven or eight miles, and a fair shot can be made two miles away.—*Evening Post.*

JETS OF AIR.

Broooklyn, N. Y., is in the throes of a great water question. "Plenty of water and let us have it pure," seems to be the demand of the citizens. Pumping water by compressed air; that is sinking pipes into the ground and raising it from its subtereanean abode by air, supplies abundant water and helps to purify it.

Mr. Frank Richards again refers to domestic refrigeration by compressed air. Ice at 40 cents per 100 pounds as against compressed air at 5 cents per 1,000 cubic feet, from a public supply would show a difference of 20 cubic feet per 100 pounds in favor of compressed air for refrigeration.

Every day thousands of people, handle compressed air recklessly, and unconsciously perhaps. The bicycle tire filled with this elastic fluid gives health, happiness, and prosperity to untold numbers. At its best it is simply compressed air.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSD AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz: All communications should be written on one side of the paper only: they should be short and to the point.

"Your paper came to hand for which I thank you. In looking through it I have studied that article particularly, entitled, "An Air Compressor of Exceedingly Novel Design." I think that this compressor when finished will be a failure. I cannot see how they can get 2,500 H. P. out of the wheel, where they have only two engines of 70 H. P. each to run it and expect to gain over 2,000 H. P. (how, I do not know). Now, in my estimation, all the power they could get out of this compressor would be 140 H. P. less the amount used to run it. You know the old saying, "No more can be taken out of a thing than there is in it." You will oblige me if you will answer this, giving me your views on the subject."

ANDREW W AITKEN,

BUFFALO, SEPT. 29, 1896. 434 7th ST.

Our correspondent asks a pertinent question.

The figures are naturally subject to criticism, but as Mr. Chaquette has succeeded in getting the money to build this novel type of Air Compressor, we presume the question will be answered by practical tests.

The machine is now nearly completed, and this fact, together with its extreme novelty and originality, induced us to describe it in COMPRESSED AIR. It is our purpose to follow it up, and give our readers some further information based on the work that this machine may, or may not perform.

There are twenty-two air hoists in the West Shore R. R. shops at Frankfort, N. Y.

Air Volumes Used in Engines.

The present increasing demand for the use of compressed air as a motive power necessarily involves the use of intricate mathematical formulæ for estimating relative sizes of Compressors and Air Engines, etc.

Quite a number of these formulæ have been worked out to cover average practical conditions and are daily serving a very useful purpose in the form of tables.

A very intricate formula is the one based upon the use of free air per minute per Indicated Horse Power in an Air Engine, and as a problem is often stated in terms of the I. H. P. of the motor—*to find the quantity of free air per minute required;* —the following table which has not been published up to the present time, will facilitate computations of this kind and is in such shape that it will not require any extended knowledge of mathematics.

As will be seen from the table, the only data required is the guage pressure and point of cut-off; having those two items given, we find from the table the free air required per I. H. P., and it will only be necessary to multiply this amount by the total I. H. P. of the motor to determine the total quantity of free air required and consequently the size of an Air Compressor to furnish the air.

AIR USED [CU. FT. FREE AIR PER MIN.] PER I. H. P. IN MOTOR [WITHOUT RE-HEATING]

POINT OF CUT-OFF	GAUGE PRESSURES.											
	15	30	40	50	60	70	80	90	100	110	125	150
1	31.2	23.3	21.3	20.2	19.4	18.8	18.42	18.10	17.8	17.62	17.40	17.05
¾	25.6	18.7	17.1	16.1	15.47	15.0	14.6	14.35	14 15	13.98	13.78	13.50
⅝	24.8	17.85	16.2	15.2	14.50	14.2	13.75	13.47	13.28	13.08	12.90	12.60
½	25.8	16.4	14.5	13.5	12.8	12.3	11.93	11.7	11.48	11.30	11.10	10.85
⅓	37.0	17.5	15.2	12.9	11.85	11.26	10.8	10·5	10.21	10.02	9.78	9.50
¼	167.	20.6	15.6	13.4	13.3	11.40	10.72	10 31	10.0	9.75	9.42	9.10

These figures do not take account of clearance, but it will be an easy matter to add the *per cent.* of clearance after having determined the total amount of free air required.

It will also be noticed that the free air consumption is based upon the use of cold air, *i. e.*, Initial temperature of air at 60° F. In case reheating is resorted to there will be a corresponding decrease in the amount used depending upon the temperature of air at admission to motor, and will be proportional to the ratio of $\frac{T_2}{T_3}$

where T_2 $460+60=520°$ F absolute temperature and $T_3 = 460 +$ temperature of air at admission to motor.

Thus if the air is reheated to 300° F, the quantity in the table will have to be multiplied by $\frac{460+60}{460+300} = \frac{520.}{760.} = .684$

A further use of this table is to find the most economical point of cut-off for gauge pressures from 15 lbs. to 150 lbs. per square inch. This fact is apparent from a study of each vertical column; thus at 60 lbs. pressure, the lowest consumption of free air per I. H. P., is at ⅓ cut-off, while a 40 lbs. pressure will work most economically at ½ cut-off.

 F. C. WEBER.

The Application of Compressed Air to Cranes and Hoists.

As it is now conceded that compressed air has become the most useful and economical addition to a modern manufacturing establishment, and as many shops are now thus equipped, a brief description of its application to cranes and hoists would be in keeping with the times, although this is but one of the many uses to which compressed air is applied. The objection urged by many against the use of compressed air for a travelling crane has been, that there was no practical way of carrying air to the crane where a long travel was used, but as different cranes are now in successful operation, a description of some of these should quiet their apprehension.

The Ingersoll-Sergeant Drill Co. have for a long time been ardent advocates of compressed air as a power for cranes, and have fitted up their shops at Easton, Pa., completely with such; the following description being of cranes in continuous operation at their works.

Figure 1, here illustrated, is a cut of a 20-ton travelling crane in their main machine and erecting shop, the crane having a span of 40 ft., and a travel of 460 ft. As it is shown by the cut, each movement of the crane is controlled by a separate engine, the three engines being piped to the valve box in the cage, where three levers control the movements of the crane. In order to avoid the complication of a link and two eccentrics for each cylinder of the duplex engine, a special engine was designed, the cylinders of which have two sets of ports, one direct and the other crossed, but having a common exhaust, the valves having both a rocking and a shifting motion with one eccentric only used for

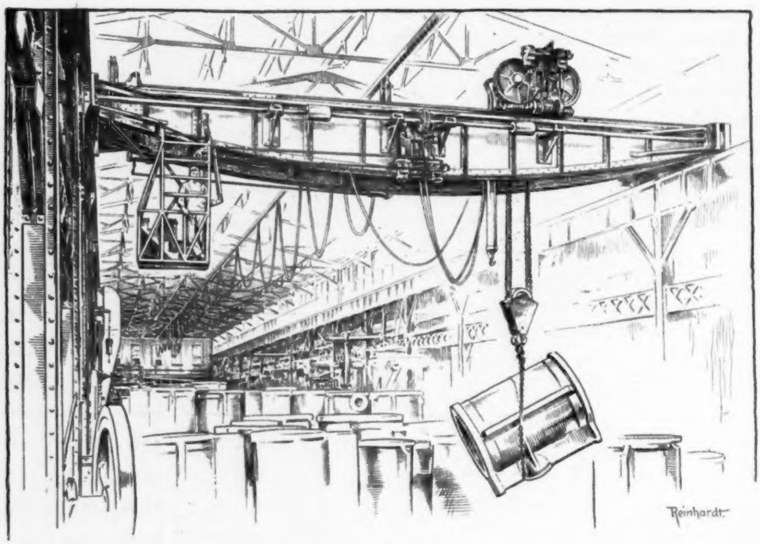


FIG 1.—COMPRESSED AIR CRANE.

each cylinder. A double set of supply piping is run from the valve box in cage to each engine, so that when the levers are moved in either direction, opening the air to either pipe, the engine valves are shifted by the air coming in on one side and the engine has the desired movement, When the lever is reversed, the air passes through the other pipe, the valve is shifted to the other end of chest and the engine is reversed in its movement.

As the hoisting engine on the carriage of the crane moves the length of the crane, the two pipes carrying the air to this engine are only run to the centre of the crane and fastened to the girders. Two lengths of hose are run from there to the engine, the hose being placed one in front of the other that one will pass through the other, and both only sufficient length to reach from the centre of the girder to the end. The engine which gives the transverse motion to the crane is set on the opposite end of crane and draws the carriage backward and forward with a wire cable.

Probably the most interesting part of the crane to the general observer, is the novel method of carrying the air to the crane. As is clearly shown by the cut, this is accomplished by a continuous hose built up of 50 ft. lengths coupled together, each coupling being made in combination with a swiveled sliding block, which slides on the overhead rail bolted to the roof truss and preferably made of I beams. In the centre of each length of hose is a clamp to hold the hose, also made with a swiveled slide. The hose is fastened to the building at one end and to the crane at the other, it being suspended at intervals of 25 ft. to the overhead rail by the swiveled slides. As the crane moves away from the hose, the hose is pulled along, each length straightening out and pulling the next length. On the return travel of the crane, as the sliding blocks come together, the hose falls in loops, the swivel in slide allowing each loop to turn around to its natural position, which is at right angles to the overhead track. It is thus seen that each loop of the hose requires only the room occupied by one sliding block on the rail, which was made 6 in. long, so the hose for the entire travel of 460 ft. occupies only 9 ft. at one end of the shop where the crane is never used.

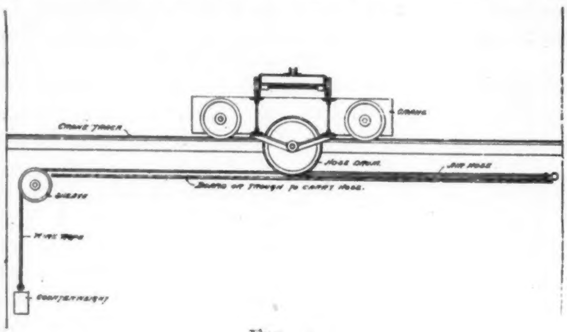


FIG. 2.

The above method of transmitting air has been in succesful operation for some time at these works and has never caused any trouble, and as it is such as can be used in all cases regardless of the length of travel, it can be recommended as the best method as has yet been devised. Should it become necessary to put in a second crane, the hose would be attached to the opposite end of the building and slide on the same overhead rail.

Where a crane is used where there is no overhead room for the hanging hose, the arrangement shown in Fig. 2 will be found very simple and effective. This consists of a wooden drum hung at one end of the crane and of sufficient size to carry the length of hose required. One end of the hose is fastened to one end of the building, the other end being held to the hollow shaft of the hose drum, said shaft having

sleeve and stuffing box at the end through which the air passes to the hoist. Underneath the hose is a board or trough on which the hose lies as it is unwound. On the same drum with the hose is a ¼ in. wire rope wound betweeu the coils of the hose. One end of the rope is fastened to the drum, the other end passing through a sheave at the end of the building, and having a weight sufficient to turn the drum attached to same. Referring to Fig. 2, as the crane moves to the left, the hose, being held stationary at the right, will unwind the drum, which will at the same time wind up the rope, or if moved to the right the rope will unwind the drum and wind up the hose. The weight on the end of the rope is made to keep the hose and rope taut and to wind up the hose, the sheave

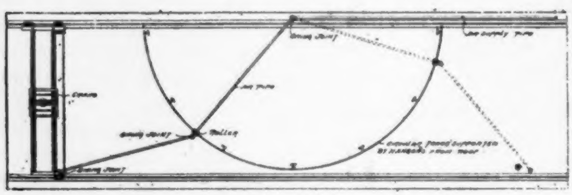


FIG. 3.

wheel allowing the weight to move up and down, this being necessary owing to the difference in diameter of the rope and hose and the corresponding difference in the length of a coil of rope or hose on the drum. The movement of weight for 100 ft. of travel of crane is about 5 ft. The one objection to this arrangement of crane is that if the travel of crane is long, the drum must be large reducing the effective span of the crane.

Fig. 3 shows a hand power crane with an air lift used in the foundry cleaning shed. Two pipes with swing joints carry the air to the crane; the centre joint being made with a roller runs on a circular track hung from the roof, which in this building is very low. The limit of travel with this crane is about three and one half times the span, but can be used in many places where hose may be objectionable.

In the foundry of this establishment there is a Compressed Air Power Travelling Crane similar to that shown on Fig. 1, and a Craig Ridgeway Pneumatic Hydraulic Jib Crane which uses compressed air instead of steam for putting the water under pressure. This crane uses the same water continuously, the air only being discharged as the weight is lowered.

The air hoist has lately been receiving considerable attention, many valuable improvements having been made which make the hoists more convenient and easily handled and bring them into general use wherever light lifting is required. The two general methods of applying the hoists, in addition to being used on a travelling crane, are first, where they are attached to the trolley of a jib crane, receiving their air through a hose leading from an air pipe at the crane post to the hoist, the latter being thus at all times ready for use; and second, where the hoist is hung to a trolley running on an overhead rail. With this latter method, the air pipe is made with outlets at specified places wherever the hoisting is required, each outlet having a length of hose with a valve and quick acting coupling attached to same. The hoist is moved along the rail to where required, the air hose coupled to it, the load lifted, the hose uncoupled, and the hoist with its suspended load is ready to be moved by hand or cable to wherever the overhead rail will carry it. This is very quick in its operation, unlimited in its application, and is by far the best method that has as yet been devised for the handling and conveying of merchandise of any description and weight from one location to another, or wherever an overhead rail can be conveniently carried.

In conclusion, it should be remembered

that compressed air is a power economically produced, clean and convenient to handle, and understood by all, so that wherever used, men of ordinary intelligence can be employed to operate the machinery and keep it in order.

WM. PRELLWITZ.

Compressed Air Without "Technique."

In a Chinese testimonial, voluntarily given, to a manufacturer of air compressors in this country, the success of their mine at Kushantzu is dated from the usefulness of the plant sent them. If any super-civilized "white man" thinks that of small value, as coming only from a lot of ignorant "celestials," it would be but one of the many common errors current about that wonderful people. In analytical acumen, in quick appreciation of any improved method, when reasonably demonstrated, no people surpass them up to the limit of their intelligence.

The late Tong King Sin was one of the clearest headed, bravest hearted men I have ever met, and to watch the tear start and roll down his face, as we discussed the great possibilities for his native land, suggested and demonstrated by the late success at Kushantzu, was a revelation.

What has this to do with compressed air? Well, as the coolies used to say, "Ach! see how it makes it go," when the drill walked into the rock or the water went up the shaft. This appealed to their quaint imagination as a power from the invisible or spirit, and to their philosophic credo what a power to lay hold of, air! that in the eastern imagination, "bloweth where it listeth, no man knowing whence it comes or whither it goeth,"—a machine or "Chi-Chi" as they call it — so like a man, taking the air in, blowing it out again, to make it do work, as we breath to live and work. Now you will see a little what compressed air had to, and may be made to do, in civilizing China. It does not seem improbable that this machinery did more in that direction, than millions of dollars worth, at missionary rates, of moral philosophy and ecclesastical creeds can do. When crossing the Pacific, in conversation with a missionary about our different missions, I told him jokingly that I was taking forty tons of civilization in the hold of our good ship. He asked, "In what way?" "Machinery!" Little anticipating how much truth and importance there was in the joke. But then, you see it happened to be the right kind and for the right purpose: viz., compressed air.

As one watches those fine looking cars come over the hill-top at 125th street, New York, in regular order with the cable cars, but in their own peculiar, graceful, majestic, noiseless fashion, skimming along as if conscious of a wonderful mission, as pioneers of a new epoch, the feeling is suggested: "Is the hour and man here at last," waited and struggled for so long against terrific odds, and what sometimes seemed the fiat of fate by men who knew that the everlasting, all powerful laws of nature waited but for the inevitable sacrifice and loving obedience to be rendered, to yield another revelation of the natural powers provided for our use and progress.

Men may come, and men will go, but the true engineer will ever rejoice in the advancement of his science and profession, and in the honor justly due (not always accorded) to everyone so worthy as our friend Hardie for his years of struggle.

History repeats itself. Years ago I had the aquaintance of an engineer who served his apprenticeship under George Stephenson, the "father of railways." He could relate incidents and experiences of the most diverse kind by the hour, of the opposition, the criticisms, positive dread and hatred of everything like a railway. I have heard and read criticisms and prophecies concerning this, that seemed but a reproduction of my friends reminiscences.

The "absolute" is as essential in professional ethics, as it is in all our calculations. Absolute consecration to truth, in science, is surely the manhood in any profession. Absolute fact, is the only bed rock safety for all. These virtues will have splendid illustration in this demonstration.

Some theoretic claims of doubtful value are not substantiated, but, the great solid, sensible claims for compressed air are being established more firmly every day. These two cars run their 161½ miles a day and carry with ease, comfort and dispatch, 1,000 passengers through the busy traffic of New York City.

In the words of the Chinaman, "it makes it go," for go it does, and has done to the extent of 8124 miles, and 52,351 passengers, carried with injury to none; but by ample evidence, in several cases, preventing what would inevitably have been serious accident with either cable or electric cars, under like conditions. It goes as another Chinaman said, "No pullee, no pushee, but it goee like hellee." Whether to the Chinaman, the most cultured critic, or the cautious investor, or in spite of them, this going will prevail, as it is the simple movement of a natural inevitable, in which we all ought to rejoice.

With every possible detail as to cost, maintenance, facilities and behavior, every natural phenomena noted and based on these facts, this demonstration will rear an everlasting monument to those whose enterprise and skill have made it possible, surely worthy of all praise and honor amongst us. The next great achievment for some of us will be in reducing the cost of compression, by better use of the steam and getting rid of the crude, clumsy momentum and consequent concussion, affecting all sizes of plant.

J. CRABTREE.

A new scheme for driving a bicycle without a chain has been patented in England. This one not only does away with the chain, but also with pedal cranks. The motive power is to be compressed air. In place of the present cranks the inventor puts an air pump on either side of the bicycle frame, with foot pieces on the plungers of the pumps. These pump air into a tank between the pumps. Then, to drive the machine, he puts two engine cylinders on the frame above the tank and connects these by cranks and pitmans to the hub of the rear wheel. The rider is to pump away, compressing air in the tank at about the same rate whether he is going up hill or down, or on a level. He controls the amount of air which is to pass into the engines by a valve, and he lets in power to these just in proportion to the speed required or the difficulties of road to be overcome. When he is going down hill or on a level he is supposed to be able to store up power in the air tank for the harder parts of the road.—*N. Y. Sun.*

Mr. James W. Dodge, Phila, Pa., has invented and patented an "Air Conveyor," the object of which is to apply air pressure in such a way that the material to be moved is lifted from the conveyor trough and carried forward at the same time. It consists of a tubular conveyor closed throughout its entire length with the exception of a series of openings at the bottom. These openings are inclined toward the outlet end, so that air entering the conveyor through the openings will act to feed the material along the conveyor as well as to sustain it in its travel.

Wm. Woolstencroft, Sons & Co. have recently shipped three of their large size caulking tools to a firm in Austria, and are receiving orders from other European countries. They are also equipping every plant in the United States owned and operated by Norcross Bros. When the whole order has been completed it will number in all fifty-six tools.

COMPRESSED AIR.

(CONTINUED.)

Otto Van Guericke invented the air-pump in 1650. In 1753 Holl used an air engine for raising water. At Ramsgate Harbor, Kent, in the year 1788, Smeaton invented a "pump" for use in a diving apparatus. In 1851, William Cubitt, at Rochester Bridge, and a little later an engineer, Brunel, at Saltash, used compressed air for bridge work. In 1852, Colladon patented the application of compressed air for driving machine drills in tunnels. The first notable use of compressed air is due to Prof. Colladon, of Geneva, whose plans were adopted at the Mont Cenis tunnel. M. Sommeiller developed the Colladon idea and constructed the compressed air plant illustrated in Fig. 7.

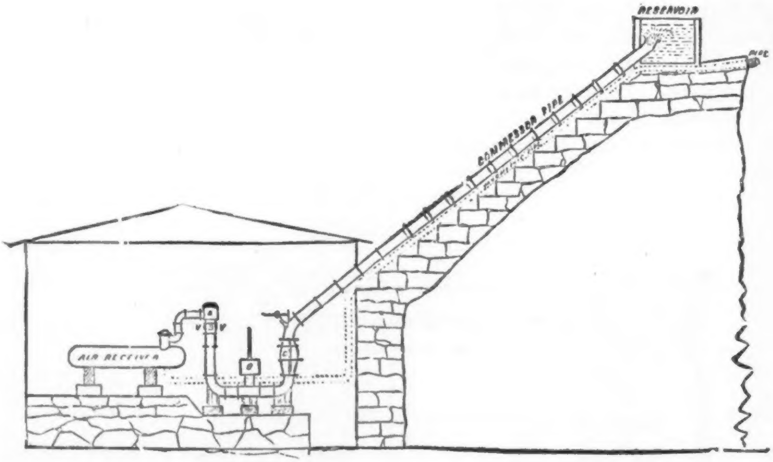


FIG. 7.—SOMMEILLER AIR COMPRESSOR USED AT THE MT. CENIS TUNNEL.

The Sommeiller compressor was operated as a ram, utilizing a natural head of water to force air at 80 pounds pressure into a receiver. The column of water contained in the long pipe on the side of the hill was started and stopped automatically, by valves controlled by engines. The weight and momentum of the water forced a volume of air with such shock against a discharge valve that it was opened and the air was discharged into the tank; the valve was then closed, the water checked; a portion of it was allowed to discharge and the space was filled with air, which was in turn forced into the tank. The efficiency of this compressor was about 50 per cent.

At the St. Gothard tunnel, begun in 1872, Prof. Colladon first introduced the injection of water in the form of spray into the compressor cylinder to absorb the heat of compressson.

Fig. 8 illustrates the air cylinder of the Dubois-Francois type of compressor, which was the best in use about the year 1876. This compressor was exhibted at the Centennial Exposition and was adopted by Mr. Sutro in the construction of the Sutro tunnel. A characteristic feature seems to be to get as much water into the cylinder as possible. The water which flooded the bottom of the cylinder arose from the voluminous injection; this water was pushed into the end of the cylinder and some of it escaped with the air through the discharge valve.

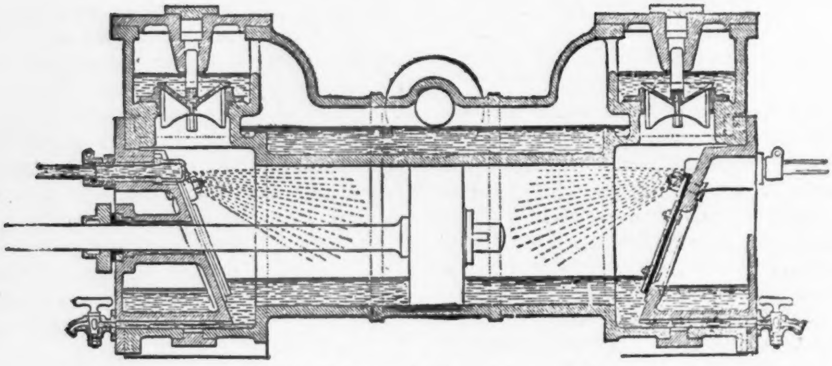


FIG. 8.—DUBOIS & FRANCOIS, 1876.

An improved pattern of this compressor is shown in Fig. 9.

The first air compressor used on a large scale for practical work in America is shown in Fig. 10.

This machine was used at the Hoosac Tunnel, being built a little prior to 1866. The design was made under the direction of the Massachusetts State Commission, of which Mr. John W. Brooks was chairman and Mr. Thomas Doane, chief engineer for tunnel construction. It is believed that Mr. Doane deserves the largest share of credit for the invention and development of this compressor, and it is to the credit of these early designers to note that after the completion of the Hoosac Tunnel the compressor was transferred to the Marble Quarries, at Sutherland Falls, Vt. (now called Proctor), and that it has been used continuously up to the present time, compressing air to about 40 pounds to the square inch. Rock drills and channeling machines of modern construction are now using this air for quarrying the beautiful marble of Vermont.

The first channeling machine was tried in this quarry perhaps with compressed air furnished by the Hoosac Tunnel compressor.

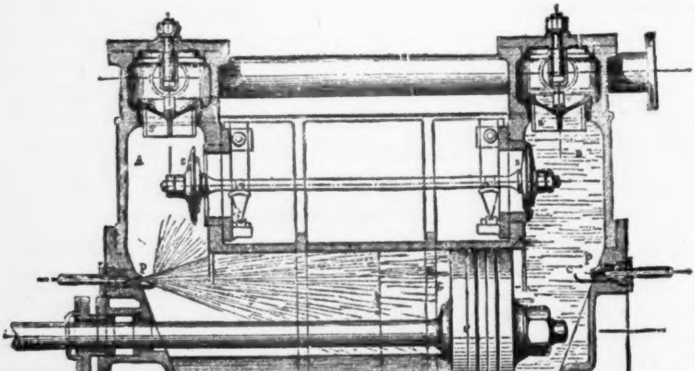


FIG. 9.—DUBOIS & FRANCOIS, 1884.

The compressor is so simple that it may be readily understood by looking at the plan. It consists of 4 horizontal air cylinders, the pistons of whfch are propelled by a turbine wheel. The cylinders are single acting, the air being admitted through poppet valves placed in

the piston. Each cylinder is 13 in. in diameter by 20 in. in stroke. It was originally intended for a speed of 120 revolutions per minute, but it has been run over 70 revolutions. The cooling arrangement applied to this compressor was simply an injection of water through the inlet valves into the cylinders, though since it's use at Hoosac Tunnel, injection has been abandoned, and a simple stream of water from a jet is allowed to play upon the cylinders.

These illustrations are interesting from an historical point of view, as indicating the line of thought which early designers of air-compressing machinery followed. As the necessity for compressed air power grew, inventors turned their attention to the construction of air-compressing engines that would combine *efficiency* with *light weight* and *economy of space and cost.*

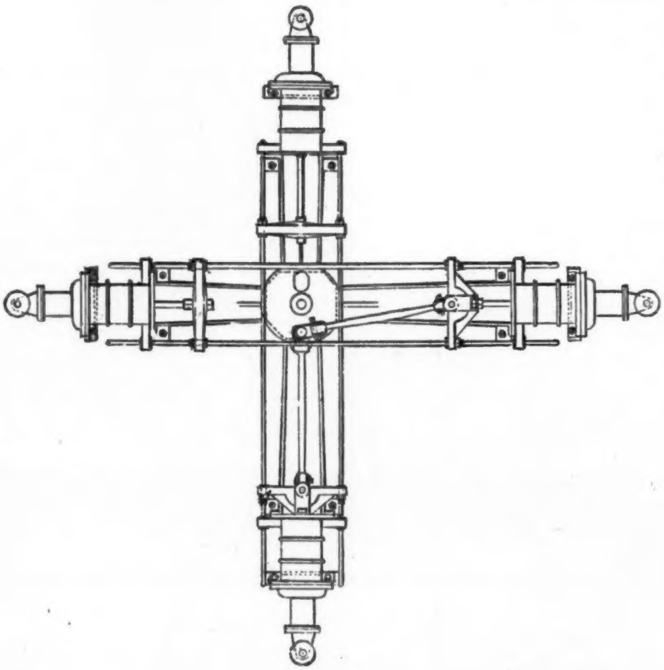


FIG. 10.

The trade demanded compressors at inaccessible localities, and in many cases it was preferred to sacrifice isothermal results to simplicity of construction and low cost.

It is evident that an air compressor which has the steam cylinder and the air cylinder on a single straight rod will apply the power in the most direct manner, and will involve the simplest mechanics in the construction of its parts. It is evident, however, that this straight line, or direct construction, results in an engine which has the greatest power at a time when there is no work to perform. At the beginning of the stroke, steam at the boiler pressure is admitted behind the piston, and as the air piston at that time is also at the initial point in the stroke, it has only free air against it. The two pistons move simul-

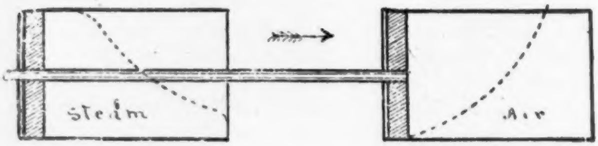


FIG. 11.—DIRECT COMPRESSION ILLUSTRATED IN THE STRAIGHT LINE AIR COMPRESSOR IN WHICH THE MOMENTUM OF THE FLY WHEEL EQUALIZES THE PRESSURE.

taneously as the resistance in the air cylinder rapidily increases as the air is compressed. To get economical results it is, of course, necessary to cut off in the steam cylinder so that at the end of the stroke, when the steam pressure is low, as indicated by the dotted line (Fig. 11), the air pressure is high, as similarly indicated in the other cylinder. The early direct-acting compressor used steam at full pressure throughout the stroke. The Westinghouse pump applied to locomotives, is built on this principle, and those who have observed it work have perhaps noticed that its speed of stroke is not uniform, but that it moves rapidly at the beginning, gradually reducing its speed, and then seems to labor until the direction of stroke is reversed. This construction is admitted to be wasteful, but in some cases, notably that of the Westinghouse pump, economy in steam consumption is sacrificed to lightness and economy of space.

Many efforts were made to equalize the power and resistance by constructing the air compressor on the crank shaft principle, putting the cranks at various angles, and by angular positions of steam and air cylinders. Several types are shown in Fig. 12.

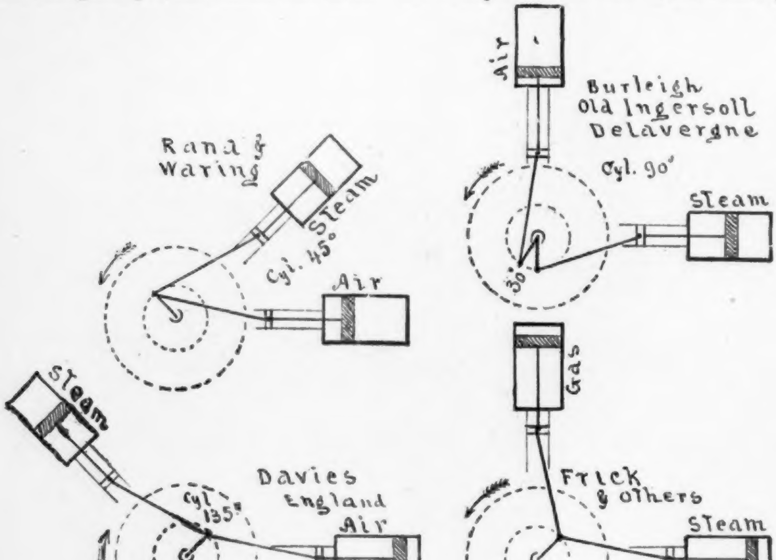


FIG. 12.

Angular positions of the cylinder involve expensive construction and unsteadiness.

Experience has proved that there is nothing in the apparent difficulty in equalizing the

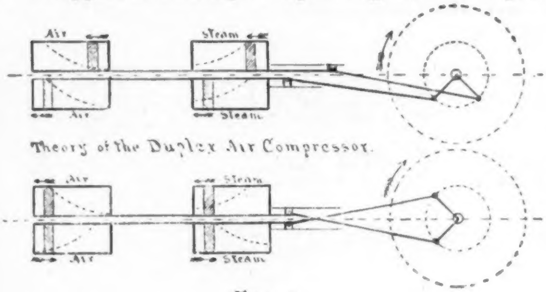


FIG. 13.

strains in a direct-acting engine. It is simply necessary to add enough weight to the moving parts, that is, to the piston, piston rod, fly wheel, etc,, to cut off early in the stroke and secure rotative speed with the most economical results and with the cheapest constrnction. It is obvious that the theoretically perfect air compressor is a direct-acting one with a conical air cylinder, the base of the cone being nearest the steam cylinder. This, from a practical point of view, is impossible. Mr. E, Hil! in referring to the fallacious tendencies of pneumatic engineers to equalize power and resistance in air compressors, says:

"The ingenuity of mechanics has been taxed and a great variety of devices have been employed. It is usual to build on the pattern of presses which do their work in a few inches of the end of the stroke and employ heavy fly wheels, extra strong connections, and prodigious bed plates. Counterpoise weights are also attached to such machines; the steam is allowed to follow full stroke, steam cylinders are placed at awkward angles to the air-compressing cylinders and the motion conveyed through yokes, toggles, levers; and many joints and other devices are used, many of which are entire failures, while some are used with questionable engineering skill and very poor results."

W. L. SAUNDERS.

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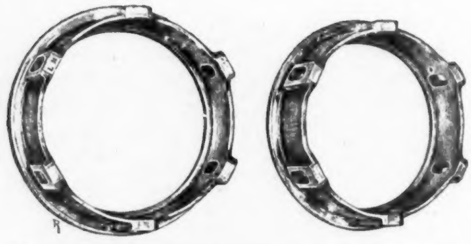

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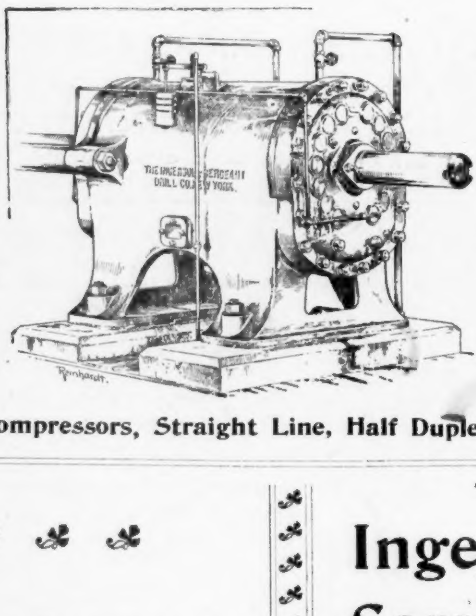

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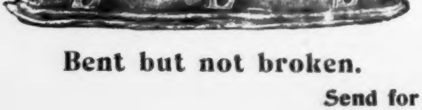

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